Farming Without Harming

Flagship research center shares expertise, puts scientific findings into practice—to benefit both agriculture and the environment.

For decades, ARS scientists at the Henry A. Wallace Beltsville (Maryland) Agricultural Research Center and around the country have helped wildlife scientists on two fronts: sharing their knowledge of domesticated farm animal behavior and biology and helping protect wildlife from possible agricultural contaminants, including pesticides and grain molds. One example of this longstanding cooperation involves Beltsville experts on livestock feed contaminants who are working closely with scientists at the U.S. Department of the Interior's Patuxent Research Refuge in Laurel, Maryland, on contaminants of wildlife feed.

The Patuxent Wildlife Research Center comprises 12,800 acres next to BARC's approximately 7,000. Having the nation's largest agricultural research center and the nation's largest wildlife research center side by side, sharing a heavily forested area with its own indigenous wildlife, has resulted in many interactions between both the wildlife and agricultural researchers—and between the researchers and the land.

It began as early as 1965, when planners at the Interior Department recognized what is not obvious to most people: Wild birds and animals are physiologically similar to domestic livestock. That year, they elected to place a new endangered species unit at the existing Patuxent Research Refuge because of the nearby presence of some of the world's leading poultry scientists, at BARC.

That decision soon paid off. By 1968, the world's whooping cranes had dwindled to one flock of 48 in a Texas marsh plus a handful at Patuxent. George Gee, a physiologist at Patuxent, tapped the expertise of Tom Sexton, an ARS poultry researcher, to save the cranes' gene pool. Sexton had developed ingredients to increase the volume of turkey semen to artificially inseminate more birds. He also developed techniques to freeze semen.

Sexton and Gee adapted the ARS turkey propagation techniques to whooping cranes. They banked frozen semen as an insurance policy in case something should happen to the world's last flock. And they used artificial insemination to build up the captive flock to 200 birds.

The two later adapted the techniques to build up the numbers of bald eagles, sparrow hawks, Andean condors, Aleutian Canada geese, turtles, alligators, and Siberian ferrets. The Siberian ferrets were experimental stand-ins for the endangered black-footed ferrets found in the United States.

KEITH WELLER (K8907-1)

ARS-developed techniques for turkey semen (shown above) have been used at the Patuxent Wildlife Research Center to increase populations of endangered species such as the bald eagle and whooping crane.

STEPHEN AUSMUS (K10729-1)

Using a freezer mill, chemist Laura McConnell prepares amphibian tissue samples for pesticide analysis.

Pesticides and Wildlife

Close collaboration between BARC and Patuxent researchers continues today. For example, Cliff Rice, a BARC Environmental Quality Laboratory (EQL) chemist who was formerly with Patuxent, is now working with Patuxent scientists to discern the effects of pesticide contaminants on ospreys.

Rice came to BARC about 12 years ago and collaborates with his former supervisor on pesticide contamination studies. Their joint goal is to ensure that the work of farming can be done successfully with a minimum of harm to the environment.

Rice published a paper this year in the *Archives of Environmental Contamination and Toxicology* describing his work with ARS colleague Krystyna Bialek; Patuxent

ecotoxicologist Donald W. Sparling; the late Laura Mazanti, formerly with UDSA's Natural Resources Conservation Service (NRCS); and colleagues from NOAA and the University of Maryland's Chesapeake Biological Laboratory and Biological Resources Engineering Department. Sparling is an authority on amphibian ecotoxicology. The paper is one of two by EQL scientists on the possible role agricultural pesticides may play in the disappearance of frogs. Frogs are one of the most sensitive indicators of environmental health.

The scientists took native gray treefrog tadpoles from ponds at Patuxent, placed them in aquarium tanks, and exposed them to doses of the three pesticides common in rain runoff at the edge of farm fields in the mid-Atlantic Coastal Plain area during the growing season. They also set up 12 outdoor ponds at Patuxent.

"We saw a pattern of exposure that was similar to what we've seen in actual wetlands—high initial exposures caused by spring rains right after herbicides and insecticides are applied," Rice says.

The study showed that a combination of three commonly used pesticides—atrazine, metolachlor, and chlorpyrifos—could play a role in frog disappearance. While those pesticides break down faster in outdoor ponds than in lab aquarium tanks, there are cases where exposure can persist for extended periods and tadpoles may be harmed.

Blowing in the Wind

An earlier paper, published in *Environmental Toxicology and Chemistry* in 2001, concerned pesticides and amphibian population declines in California. Laura McConnell, an ARS chemist and EQL authority on the atmospheric deposition of pesticides, did the study with Sparling and Gary M. Fellers, who is with the U.S. Geological Survey's Western Ecological Research Center at Point Reyes, California.

They investigated the possibility that wind-blown pesticides—particularly organophosphate insecticides—have a role in the drastic decline of toads and frogs over the past two decades in the Sierra Nevada Mountains downwind of the intensely agricultural San Joaquin Valley. McConnell says that, "We didn't prove that pesticides cause this decline, just that it is a possibility. But we did demonstrate that the concentrations and frequency of pesticide detections in amphibian tissue follow north-south and west-east patterns consistent with intensified agriculture upwind of the areas with the most serious amphibian declines. And we showed that the pesticides are present in the frog tissue and that the frogs have been exposed to pesticides."

Pacific treefrog tadpoles and adults were sent to the EQL for analysis for the presence of pesticides in their tissue. They were also sent to Patuxent to measure levels of an enzyme that indicates exposure to organophosphate insecticides. More than half of the tadpoles and adults from Yosemite National Park in

KEVIN THORPE (K10730-1)

A ground-based application of GYPCHEK, a virus-based biopesticide for gypsy moth control, being applied at BARC.

STEPHEN AUSMUS (K10727-1)

Herons on the BARC farm are among many bird species benefiting from sustainable agricultural practices developed by ARS and used there for over a decade. During this time, pesticide use on the farm was reduced 75 percent.

STEPHEN AUSMUS (K10725-1)

After a vertical climb totaling 85 feet, biologist Elwood "Woody" Martin of the U.S. Fish and Wildlife Service/Patuxent Wildlife Research Center pauses for a moment on the edge of a bald eagle's nest before banding a young bird.

California's Sierra Nevada—downwind of the agricultural area—contained measurable levels of these chemicals, compared with only 9 percent at the coast.

The evidence from that study added to a growing body of evidence from other published studies that wind-blown pesticides from Central Valley farms may have played a role in the decline of amphibians in the Sierra Nevadas.

The results of the Sierra Nevada study also matched observations by ARS, NRCS, and Patuxent scientists, both from the Patuxent study and when they visited farm ponds on Maryland's Eastern Shore. For example, at one of the experimental outdoor ponds at Patuxent, they saw complete mortality of frogs, crayfish, fish, and other aquatic life, seemingly caused by a combination of chlorpyrifos, an organophosphate insecticide, with the herbicides atrazine and metolachlor. Drifts of these sprays are common during the growing season. This, and other studies conducted by EQL scientists and others, indicate that pesticide drift might play a role in the disappearance of frogs worldwide, although it doesn't appear to cause frog deformities. It may be that if pesticides have any harmful effect, it is only in combination with other stresses, such as increased ultraviolet rays, attack from fungi, and infections.

GYPCHEK, World's First Virus-Based Biopesticide

Insect pests of agricultural importance can also be important to wildlife researchers. The gypsy moth demonstrates both that connection and the value of native fauna and flora to researchers.

For example, the trees at BARC and surrounding properties gave ARS scientists at the Insect Biocontrol Laboratory (IBL) the chance to help turn a natural virus into one of the first virus-based biopesticides. Called GYPCHEK, the biopesticide has proven effective over years of ARS research in controlling gypsy moths. The only reason it has not gone into commercial

production has been the lack of a company willing to manufacture and market it.

ARS entomologist Kevin Thorpe and his IBL colleagues, working with USDA's Forest Service and Animal and Plant Health Inspection Service, hope to change that by lowering the costs of mass-producing the virus. They are seeking a way to grow the virus in a lab, instead of in live gypsy moth caterpillars. The mass-rearing of caterpillars adds too much to the production costs, making it less viable commercially.

GYPCHEK was recently used to treat 1,000 acres at BARC, along with 3,024 more acres owned by Patuxent, NASA's Goddard Space Flight Center, and three other federal agencies. This was the first operational use of GYPCHEK on the "Green Wedge," a mass of heavily forested land owned by BARC, Patuxent, and other government agencies in the Washington, D.C., suburbs. It was one of the largest operational uses of GYPCHEK made to date.

Thorpe not only researches gypsy moths, he also runs a program to control them at BARC. In 1988, a couple of years before his arrival, the moving gypsy moth "front" reached BARC unexpectedly, causing defoliation that hurt birds and wildlife. It also had the potential to cause "forest fragmentation" as has happened in many places in the Northeast—often because of gypsy moth invasion. BARC countered with a control program that has prevented significant additional damage from occurring.

For this control program, Thorpe and colleagues count egg masses and use those counts to decide when to spray.

STEPHEN AUSMUS (K10719-1)

A healthy fox pup explores a part of the almost 20 thousand acres that make up the BARC research farm and the Patuxent Wildlife Research Center, which are next to each other.

Coexisting With a Multitude of Species

Thorpe heads the BARC Ecology Committee, which was founded in 1977 by Paul Putnam, then BARC director, to protect the fauna and flora of the forested Green Wedge while farming and researching at BARC.

Many forest-dwelling birds live on the Green Wedge, including neotropical birds that migrate from South to North America each year to breed or stay for the winter. The area is home to a variety of other birds, including nesting bald eagles, hawks, owls, bluebirds and several other songbirds, wild turkeys, herons, and waterfowl. Many species of warblers sensitive to forest fragmentation live there, too, along with beavers, muskrats, deer, foxes, raccoons, opossums, groundhogs, and other four-legged animals. Several uncommon fish species occur in the streams. Frogs, salamanders, snakes, turtles, lizards and other amphibians and reptiles—plus diverse insects—are among the Green Wedge's wild inhabitants.

Biodiversity Meets Sustainable Agriculture at BARC

The first step in protecting fauna and flora is to document exactly what you have.

So that's just what Edward Terrell, a retired BARC botanist, did. He led a team that recently finished an inventory of the flora of BARC. Joseph H. Kirkbride, a botanist with the ARS Systematic Botany and Mycology Laboratory (SBML), has modified this list, which includes two rare species of orchids. His updated edition, due this summer, will include 4 more species, for a total of 905 plant species, 141 of them rare and another 12 rare to infrequent. The list is being linked to online plant photo sites and other databases so it can serve as a plant identification guide as well as a list. It will soon be accessible from the lab's home page at http://nt.ars-grin.gov.

These inventoried plants include invasive weeds of national interest, as well as desirable native plants growing in wildflower and other natural meadows at BARC. Since you have to know your enemy to vanquish it, BARC even employs a "weed librarian," Ruth Mangum, to make sure that sufficient quantities of pest plants are available for researchers to study.

The natural meadows are part of a sustainable agriculture demonstration project on BARC lands. More than a decade ago, the farm began using sustainable agricultural practices developed through ARS research. This has resulted in a lowering of pesticide use by 75 percent. In this way, BARC has for a long time now been practicing the "farm without harm" philosophy that ARS has preached for many years. And this—along with the continuing research collaboration of two different, committed federal agencies—has led to a healthy coexistence of diverse plant and animal life in this outdoors laboratory.—By **Don Comis,** ARS.

This research is part of Water Quality and Management (#201), Air Quality (#203), and Crop Protection and Quarantine (#304), three ARS National Programs described on the World Wide Web at www.nps.ars.usda.gov.

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